

FRESHWATER TRICLADS (TURBELLARIA) OF NORTH AMERICA. XV. TWO NEW SUBTERRANEAN SPECIES FROM THE APPALACHIAN REGION

Roman Kenk

Abstract.—*Phagocata procera* n. sp. from a cave in Jackson County, North Carolina, and *Sphalloplana hypogea* n. sp. from outlets of tile drains in Isle of Wight County, Virginia, are described. They differ from related species chiefly by the anatomy of their reproductive systems.

Several active speleologists have taken the trouble of sending me living specimens of triclads or planarians collected in their explorations of subterranean habitats. This is of particular importance in the case of triclads, as it is very difficult to preserve these worms properly in the field and impossible to preserve the often characteristic shape of the quietly gliding animals. I wish to thank Dr. Cato O. Holler, Jr. of the North Carolina Cave Survey, Old Fort, North Carolina, and Dr. John R. Holsinger of Old Dominion University, Norfolk, Virginia, for their thoughtful collaboration in the study of these little known animals. Thanks are due also to Dr. John C. Harshbarger, in whose laboratory the photographs were prepared, and to Dr. Marian H. Pettibone who kindly reviewed the manuscript.

The planarians were preserved with a hot solution of mercuric chloride (HgCl_2) and the sections stained with Ehrlich's acid hematoxylin and Eosin-Phloxine B.

The type-material is deposited in the National Museum of Natural History (USNM), Smithsonian Institution, Washington, D.C.

Family Planariidae
Genus *Phagocata* Leidy, 1847
Phagocata procera, new species

Type-material.—Holotype, set of sagittal sections on six slides, USNM 81294; five paratypes, sagittal and transverse sections on 23 slides, USNM 81295-81299.

External features (Fig. 1A).—This is an exceedingly slender species, mature specimens measuring up to 17 mm in length and about 1 mm in width. The species is unpigmented (white) and blind. The anterior end is truncate, with a rather straight frontal margin and a pair of pointed auricular projections extending anterolaterally. Behind the anterior end the body widens gradually and soon reaches its maximum width which is maintained for the greater part of the body length. Behind the copulatory apparatus, the body narrows and terminates in a bluntly pointed posterior end.

The pharynx, measuring about $\frac{1}{6}$ of the body length, is inserted slightly behind the middle of the body. The copulatory apparatus is visible in living specimens as a transparent elongated area situated at about the middle of the postpharyngeal region. The intestinal area begins a certain distance from the anterior end. The branches of the intestine could be demonstrated by feeding the worms a mixture

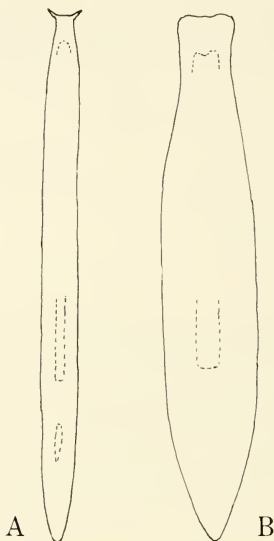


Fig. 1. Outline drawings of living planarians, indicating locations of pharynx and anterior intestinal border, $\times 6$. A, *Phagocata procera*; B, *Sphalloplana hypogea*.

of liver tissue and carbon powder. The anterior intestinal trunk bears 17–22 pairs of lateral branches and each of the posterior trunks 25–29 rather short lateral diverticula.

Anatomy.—The anterior end has no special adhesive organ. The marginal adhesive zone is normally developed and seems to surround the anterior end without interruption.

In the reproductive system, the ovaries are located behind or below the fourth pair of the anterior intestinal branches. The testes (Fig. 2) are ventral, arranged on either side of the midline in a narrow longitudinal zone beginning posterior to the ovaries and ending at the level of the pharyngeal root. In transverse sections only one or two testes are seen in each zone.

The copulatory apparatus (Fig. 3) is situated a certain distance behind the pharyngeal pouch. The genital opening or gonopore (*gp*) leads into the atrial cavities: posteriorly the common atrium (*ac*) and anteriorly the male atrium (*am*). The penis has a rather small bulb (*bp*) and a large, finger-shaped papilla (*pp*). The penial lumen is rather wide in the bulb, forming the seminal vesicle (*vs*), narrows toward the papilla as an ejaculatory duct (*de*), and widens again near its outlet on the dorsal side of the papilla. A rather large, rounded protuberance projects into the seminal vesicle from the dorsal side. The lining of the lumen in the bulb and the basal part of the papilla consists of a rather tall glandular epithelium,



Fig. 2. *Phagocata procera*, sagittal section of prepharyngeal region, $\times 190$. *in*, intestinal branch; *te*, testis; *vd*, vas deferens.

while in the distal part of the lumen (*de*) the epithelium is cuboidal. Many gland ducts with a granular, slightly bluish secretion penetrate the bulb from the surrounding mesenchyme and open into the penis lumen through the tall epithelium. The sperm ducts or vasa deferentia (*vd*), after forming the enlarged spermiductal vesicles, ascend at the level of the penis bulb, enter the bulb dorsolaterally or laterally, and open into the anterior end of the penial lumen separately, but close together.

The common oviduct (*ode*) enters the atrial cavity from the dorsal side at the boundary between the male and common atria. The copulatory bursa (*b*) shows no peculiarities. Its outlet, the bursal stalk or duct (*bd*) runs as a narrow canal along the dorsal side of the penis, then gradually widens, becomes more convoluted, and acquires a very thick muscle coat of intermingled circular and longitudinal fibers. This portion of the duct may properly be called a vagina (*va*).

The copulatory complex has no infranucleate epithelia.

Distribution and ecology.—*Phagocata procera* was collected by Dr. Cato O. Holler, Jr. and his son in two pools from a seep in Cat Den Cave, near the community of Tuckaseegee in Jackson County, North Carolina, on 8 August 1982. Seven specimens were sent to me alive, but all proved to be immature. They were placed in a culture dish, kept at 14°C, and fed beef liver once a week until they matured after several months.

Taxonomic position.—*Phagocata procera* belongs to a group of Appalachian

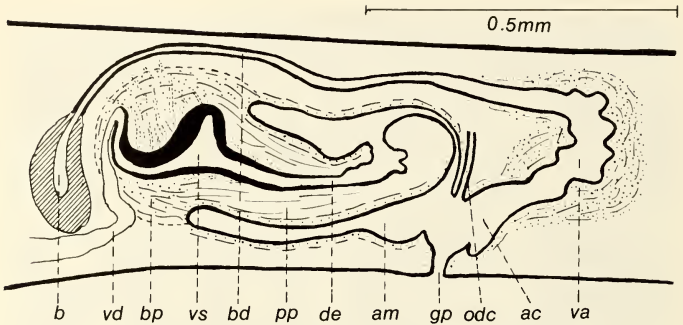


Fig. 3. *Phagocata procera*, semidiagrammatic view of copulatory apparatus in sagittal section. *ac*, common atrium; *am*, male atrium; *b*, copulatory bursa; *bd*, bursal duct; *bp*, penis bulb; *de*, ejaculatory duct; *gp*, gonopore; *odc*, common oviduct; *pp*, penis papilla; *va*, vagina; *vd*, vas deferens; *vs*, seminal vesicle.

species characterized by prepharyngeal testes, lack of pigmentation, partial or total reduction of the eyes, and a tendency to subterranean occurrence (*P. bursaperforata* Darlington, 1959; *P. angusta* Kenk, 1977b; *P. holleri* Kenk, 1979a; *P. carolinensis* Kenk, 1979b; and several still undescribed species). This group bears a great similarity to several European species frequently assigned to the genus *Atrioplanaria*. Whether or not there is a phyletic relationship between these two groups, will have to be considered from additional evidence such as possibly by a karyological or a biochemical relationship. *Phagocata procera* differs from all the related members by the dorsal opening of the penis lumen on the penial papilla and by the extraordinary development of the highly muscular vagina. It is also the most slender species of the genus as far as we know.



Fig. 4. *Sphalloplana hypogea*, adhesive organ in sagittal section, $\times 109$.

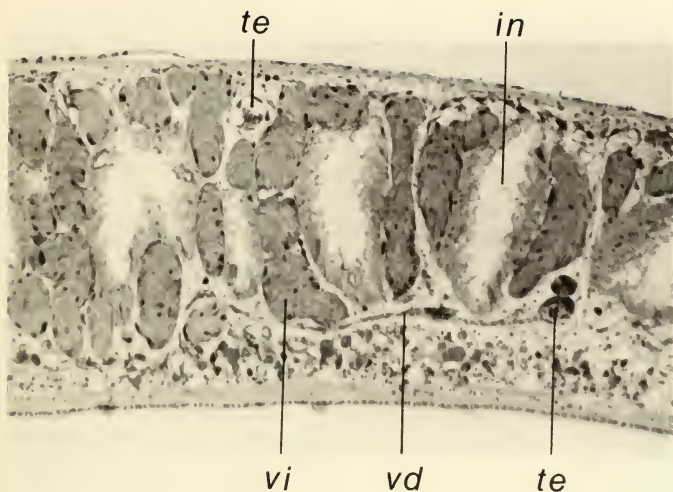


Fig. 5. *Sphalloplana hypogea*, sagittal section of prepharyngeal region, $\times 108$. *in*, intestinal branch; *te*, testis; *vd*, vas deferens; *vi*, vitellarium.

The specific name, *procera* (Latin, slender), refers to the general shape of the species.

Family Kenkiidae

Genus *Sphalloplana* Beauchamp, 1931

Subgenus *Speophila* Hyman, 1937

Sphalloplana (*Speophila*) *hypogea*, new species

Type-material.—Holotype, set of sagittal sections on eight slides, USNM 81300; paratype, set of sagittal sections on thirteen slides, USNM 81301.

External features (Fig. 1B).—Of the seven available specimens, two were sexually mature. The largest specimen measured 17 mm in length and 3 mm in width. The anterior end is truncate, with a slight incurving in the mid-portion of the frontal margin and with rounded, only slightly protruding lateral edges, lacking distinct auricular extensions. The anterior border of the intestinal area shows a slight indentation, as is characteristic of the species of the genus that have a well-developed adhesive organ. The root of the pharynx is situated at about the middle of the body and its length amounts to $\frac{1}{7}$ to $\frac{1}{8}$ the length of the body.

Anatomy.—The lateral margins of the body have a thickened epithelium underlain by densely-packed rhabdite glands, as is typical for the family Kenkiidae. The adhesive gland (Fig. 4) is well developed and consists of a deeply invaginated depression that branches into several distinct pockets, rather than a folded pit

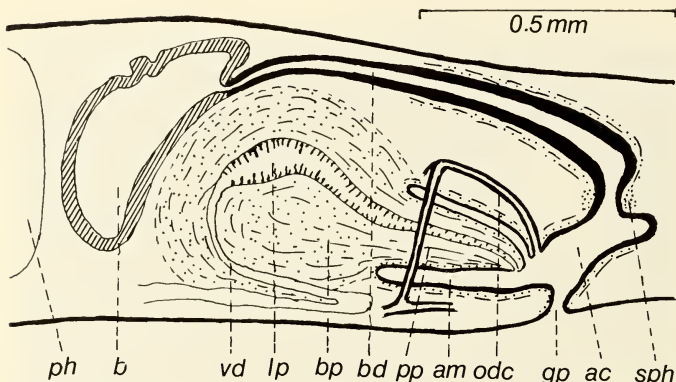


Fig. 6. *Sphalloplana hypoea*, semidiagrammatic view of copulatory apparatus in sagittal section. *ac*, common atrium; *am*, male atrium; *b*, copulatory bursa; *bd*, bursal duct; *bp*, penis bulb; *gp*, gonopore; *lp*, penis lumen; *odc*, common oviduct; *ph*, pharyngeal pouch; *pp*, penis papilla; *sph*, sphincter; *vd*, vas deferens.

that is usually seen in the subgenus *Speophila* (cf. Mitchell 1968). The internal pharyngeal musculature consists of two separate layers, an internal layer of circular fibers surrounded by a layer of longitudinal muscles.

The two ovaries are situated on the medial sides of the ventral nerve cords at the level behind the fourth lateral branches of the anterior intestinal trunk. There are no parovaria developed. The oviducts or ovovitelline ducts proceed along the upper side of the nerve cords. The testes (Fig. 5, *te*) are very small and not numerous, scattered in the dorsal, ventral, and intermediate portions of the mesenchyme. They do not form a compact zone as is usually the case, but appear on either side of the midline individually between the intestinal branches and the amply developed vitellaria (*vi*) in the region between the ovaries and the pharyngeal root. The ventral testes may be attached directly to the anterior sperm ducts or vasa deferentia (*vd*) that run somewhat medially along the oviducts, while the dorsal ones connect with the sperm ducts by vertical efferent ductules. In the region of the pharynx the sperm ducts enlarge to form the spermiductal vesicles (or false seminal vesicles).

The copulatory apparatus (Fig. 6) occupies the anterior half of the postpharyngeal region. The gonopore (*gp*) leads into a small common atrium (*ac*) that connects dorsally with the bursal duct (*bd*) and anteriorly with the male atrium (*am*). The penis is rather large, with a rounded, highly muscular bulb (*bp*) and a conical or finger-shaped papilla (*pp*). The penis lumen (*lp*) is elongate, starting in the bulb as a rather wide cavity and proceeding toward the papilla, gradually narrowing, and finally opening at the tip of the papilla. The lining of the lumen consists of an epithelium that projects numerous villus-like extensions into the

cavity. The widened lumen in the bulb apparently corresponds to a seminal vesicle and the narrowed duct in the papilla to an ejaculatory duct, although there is no histological difference between the linings of these two parts.

The two vasa deferentia (*vd*), after forming a small posterior loop, enter the penis bulb ventrolaterally, proceed in a curve upward and toward the midline, and open into the anterior end of the penis lumen separately, but close together.

At the level of the male atrium, each oviduct sends a branch of variable length (160 to 550 μm) posteriorly toward the vitellaria of the tail end of the body, while the principal oviduct ascends dorsally and unites with the duct of the opposite side. The common oviduct (*odc*) curves ventrally and opens at the junction of the male and common atria. The ascending oviducts and the common oviduct receive the outlets of numerous eosinophilic glands, the shell glands.

The copulatory bursa (*b*) is rather large and is situated immediately posterior to the pharyngeal pouch (*ph*). Its outlet, the bursal duct (*bd*), gradually widens posteriorly and acquires a thicker muscle coat consisting of intermingled circular and longitudinal fibers. Just before it joins the common atrium, it is surrounded by a strong sphincter (*sph*).

None of the epithelia of the copulatory apparatus are infranucleate.

Distribution and ecology.—*Sphalloplana hypogea* was collected by Dr. John R. Holsinger in two drain-tile outlets on the farm of Robert Taylor in Isle of Wight County (3.5 miles north of Chuckatuck, Nansemond County), Virginia, on 27 March and 24 April 1983. The tiles, about five feet beneath ground, drain a large pasture field. It appears, therefore, that the natural habitat of the species is groundwater. A total of seven specimens were sent to me alive, two of which proved to be sexually mature.

Taxonomic position.—The well-developed adhesive organ places the species in the subgenus *Speophila*. The most outstanding specific characters, apart from the configuration of the copulatory complex, are the modification of the adhesive organ, the arrangement of the testes, and the presence of a sphincter on the bursal duct. Compared to the other American species of the subgenus (see Kenk 1977a), the principal differences are the following: *S. virginiana* has ventral testes; *S. holsingeri* has the ejaculatory duct opening on the dorsal surface of the penis papilla; *S. pricei* and *S. hubrichti*, possibly the nearest relatives, have the penial lumen divided into two histologically different sections; *S. weingartneri* differs chiefly by having the penis bulb very large and the penis papilla greatly reduced; *S. buchanani* and *S. chandleri* have the testes confined to the dorsal side; and *S. mohri* is a polypharyngeal species. They all lack the sphincter on the bursal duct.

The specific name *hypogea* (from the Greek *hypogeios*, subterranean) refers to the occurrence of the species in groundwater.

Literature Cited

- Darlington, J. T. 1959. The Turbellaria of two granite outcrops in Georgia.—*American Midland Naturalist* 61:257–294.
- Kenk, R. 1977a. Freshwater triclad (Turbellaria) of North America. IX. The genus *Sphalloplana*.—*Smithsonian Contributions to Zoology* 246:iii + 38 pp.
- . 1977b. Freshwater triclad (Turbellaria) of North America. X. Three new species of *Phagocata* from the eastern United States.—*Proceedings of the Biological Society of Washington* 89:645–652.

- . 1979a. Freshwater triclads (Turbellaria) of North America. XI. *Phagocata holleri*, new species, from a cave in North Carolina.—Proceedings of the Biological Society of Washington 92:389–393.
- . 1979b. Freshwater triclads (Turbellaria) of North America. XII. Another new cave planarian from North Carolina.—Brimleyana 2:91–96.
- Mitchell, R. W. 1968. New species of *Sphalloplana* (Turbellaria: Paludicola) from the caves of Texas and reexamination of the genus *Speophila* and the family Kenkiidae.—Annales de Spéléologie 23:597–620.

Department of Invertebrate Zoology, Smithsonian Institution, Washington, D.C.
20560.